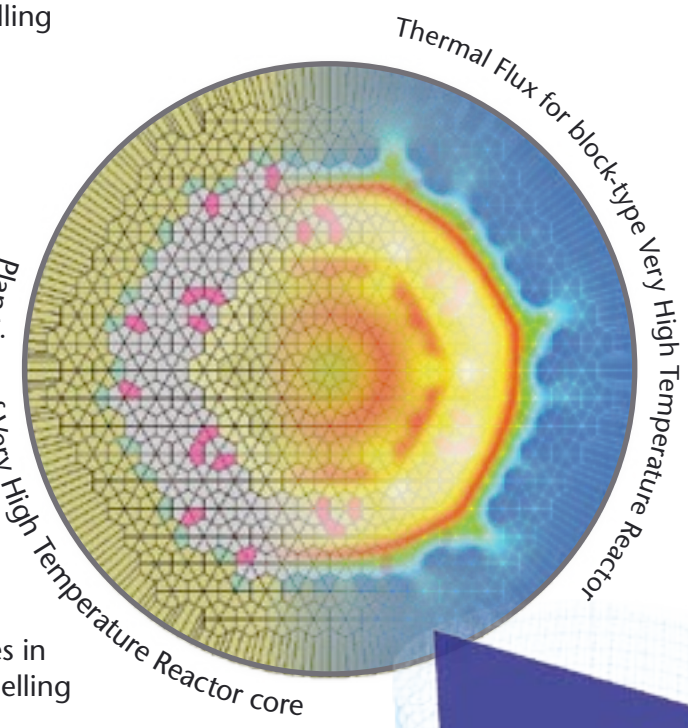
Imperial College London

Centre for Nuclear Engineering

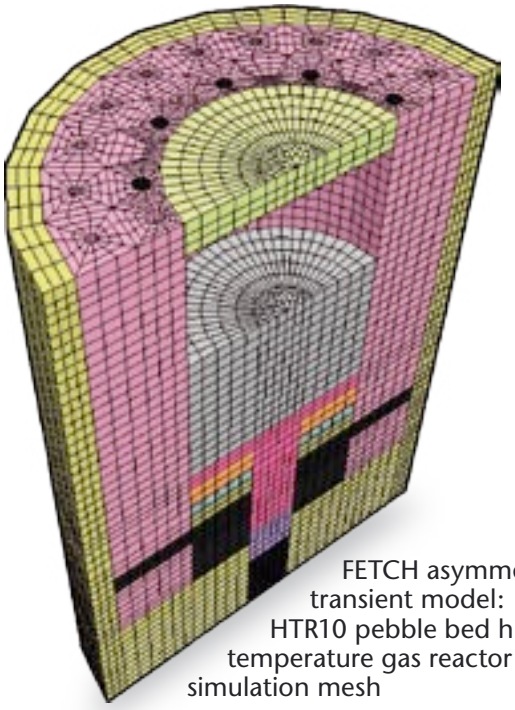
Applied Modelling & Computation Group

- Development of world-class numerical methods for modelling multi-scale multi-physical processes
- Fully coupled 3D transient nuclear fluids and structural processes
- Radiation transport, reactor physics and uncertainty modelling
- Single and multiphase fluids
- Structural processes in nuclear safety modelling

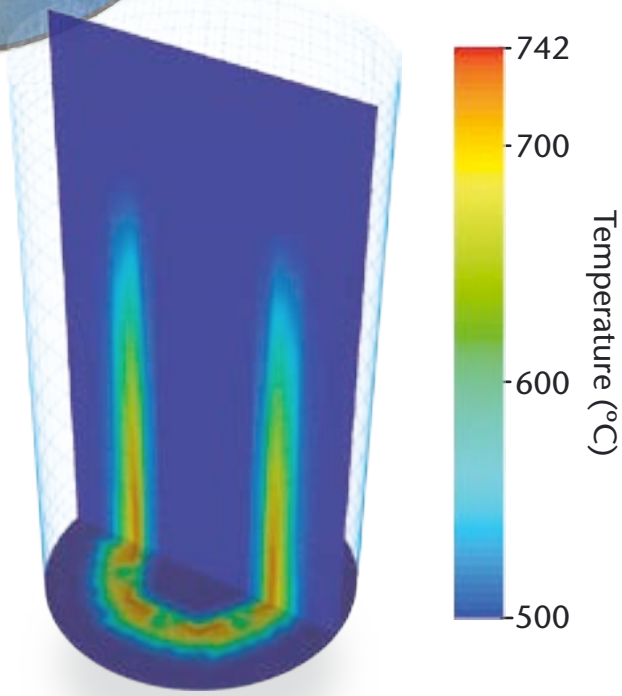


Combined finite – discrete element method for solid particulate and structural components, FEMDEM

Here, a space array of ~ 300 real-shaped particles have settled in a box - the entire spatial-temporal process being available for stress analysis



FETCH asymmetric transient model: HTR10 pebble bed high temperature gas reactor simulation mesh



Steady state 3D helium temperature distribution for Very High Temperature Reactor at half power

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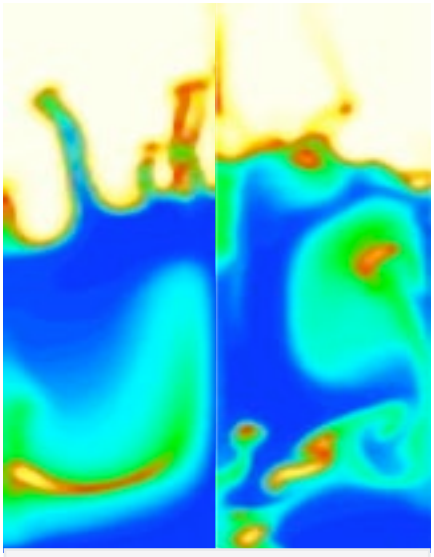
The Applied Modelling and Computation Group (AMCG) is a multi-disciplinary team of scientists and engineers with backgrounds in computational engineering, mathematics, physics and earth sciences.

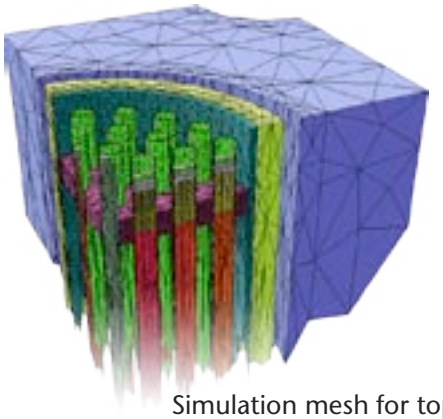


FETCH benchmark results for TRACY experiment: 2$ step-reactivity insertion simulation showing bubbles of radiolytic gas bursting at free surface of uranyl nitrate solution.

Extensive collaborative benchmarking has been conducted for the FETCH code including comparison with CRAC, SILENE (IPSN/IRSN, France) and TRACY (JAEA, Japan) experiments.

AMCG specialises in the development of world-class numerical methods for modelling multi-scale multi-physical processes in key areas such as nuclear criticality safety, reactor physics, turbulent, industrial and environmental flows.

Three general purpose finite element codes, developed by AMCG (Fluidity, RADIANT and EVENT) together with specialised codes such as the coupled multi phase CFD and radiation transport code, FETCH, provide the numerical framework for the group's research:



Simulation mesh for top of AGR fuel stringer

Fluidity

- Multi-physics computational fluid dynamics
- Arbitrary mesh movement for time dependent problems by using moving finite element/spectral element method
- Active development to model fluid and heat transfer in fluidised beds and ocean models

EVENT

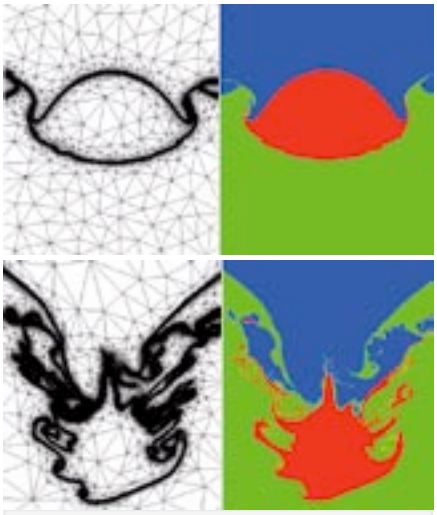
- **EV**En parity **N**eutral particle **T**ransport
- Applying the finite element method to radiation transport

RADIANT

- Imperial College's next generation neutron radiation transport model
- Uses latest developments in sub-grid scale finite element techniques
- Riemann treatments of boundary conditions provide solutions robust in any material regime
- Adaptive spherical wavelets used to represent angular flux giving distinct advantage over other techniques diffusion theory or second order formulations avoiding inherited problems of breakdown when modelling voids

FETCH

- **F**inite **E**lement **T**ransient **C**riticality
- Coupled multi-fluid radiation modelling
- Reference method for modelling criticality transients in fissile solutions and other multiphase matrices
- Generic method capable of detailed spatial and temporal modelling of coupled multiphase flow dynamics
- Detailed modelling of phase change, heat and mass exchanges. As applied to transient mixing of MOX fissile powders
- Demonstrated with conceptual fluidised bed and pebble bed reactor designs and now block-type very high temperature and gas cooled fast reactors
- Used to study transient criticality of fissile matrices in geological waste repositories at long timescales



Interface tracking technology for an arbitrary number of materials through unstructured and adaptive finite element mesh. Here, interaction between air and two materials of different densities are shown at two instances in time

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